Page Content

Operation and maintenance of bioretention and other stormwater infiltration practices

Green Infrastructure: Bioretention practices can be an important tool for retention and detention of stormwater runoff. Because they utilize vegetation, bioretention practices provide additional benefits, including cleaner air, carbon sequestration, improved biological habitat, and aesthetic value.

This page provides guidance for operation and maintenance (O&M) of **bioretention** and other stormwater infiltration practices, including above- and below-ground infiltration practices. This includes **biofiltration** (https://stormwater.pca.state.mn.us/index.php?title=Bioretention), bioinfiltration, infiltration trenches, and **infiltration basins** (https://stormwater.pca.state.mn.us/index.php?title=Infiltration).

Supplemental information can be found on the page called Operation and maintenance of bioretention and other stormwater infiltration practices - supplemental information. Supplemental information includes the following.

- Erosion protection and sediment monitoring, removal, and disposal (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Erosion_protection_and_sediment_monitoring.2C_removal.2C_and_disposal_.E2.80.93_protecting_your_investment)
- Seeding, planting, and landscaping maintenance (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Seeding.2C_planting.2C_and_landscaping_maintenance_.E2.80.93_keeping_it_looking_good)

- Snow storage (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Snow_storage)
- Sustainable service life for infiltration and bioretention BMPs (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Sustainable_service_life_for_infiltration_and_bioretention_BMPs)
- Maintenance agreements (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Maintenance_agreements)
- References (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#References)

Photo of an infiltration trench with native vegetation in Lino Lakes

Contents

Overview of typical O&M issues

Bioretention practices and other stormwater infiltration practices (e.g. rain gardens, infiltration trenches) are vegetated landscape practices that capture, filter, and infiltrate stormwater runoff. In addition, these practices can provide **ecosystem services** such as nutrient cycling and storage, **carbon sequestration**, reduction in **heat island** effect, **climate adaptation**, and habitat for bees, butterflies, and other insects and small animals, including pollinators (https://stormwater.pca.state.mn.us/index.php?title=Pollinator_friendly_Best_Management_Practices_for_stormwater_management). Bioretention and other infiltration practices may be subject to high public visibility, greater trash loads, pedestrian traffic, vandalism, and vehicular loads, particularly in urban areas.

These practices require dedicated and regular maintenance to ensure proper and long-lasting operation and ecosystem benefits. Estimated bioretention **lifespans** range from 10 to 40 years (Drescher, 2012 (https://owl.cwp.org/mdocs-posts/trees-in-bioretention/)). The most frequently cited O&M concerns for infiltration practices include the following.

- Permanent standing water or flooding due to clogging caused by **organic matter**, fine silts, **hydrocarbons**, and algal matter. Clogging can occur at the surface, or in the inlet, outlet, or **underdrain** pipes.
- Runoff **bypasses** the practice due to incorrect grading and slopes, or because the inlet is blocked.
- Accumulation of trash and debris within the infiltration practice.
- Insufficient/inadequate vegetation or overcrowded vegetation .
- Inadequate pollutant removal due to improper soil **media** (https://stormwater.pca.state.mn.us/index.php?title=Design_criteria_for_bioretention#Materials_specifications_-_filter_media) selection.

The sections below describe best practices to prevent or minimize these common problems.

Design Phase O&M Considerations

Designers should design bioretention and infiltration practices in ways that prevent or minimize O&M issues. Examples include the following.

Example of a filter strip serving as pretreatment for a bioretention practice.

- Limiting the contributing drainage area and sizing the practice in accordance to its **contributing drainage area (https://stormwater.pca.state.mn.us/index.php?title=Contributing_drainage_area_to_stormwater_BMPs)** to prevent flooding issues.
- Providing **pretreatment** (https://stormwater.pca.state.mn.us/index.php?title=Pretreatment) and **trash racks** to prevent clogging or trash accumulation.
- Providing a vegetation design plan, emphasizing
  - native plantings (see Plants for Stormwater Design (https://www.pca.state.mn.us/water/plants-stormwater-design)) to enhance pollinator and wildlife habitat, improve infiltration and evapotranspiration, reduce urban heat island effect, provide optimized carbon sequestration, and provide climate adaptation. Native plantings typically require less maintenance and replacement than non-native plantings because they are adapted to the local climate;
  - site-specific plantings that take into account sun exposure, shade, proximity to traffic corners (visibility issues), interior vs exterior plantings, salt-tolerant plants (https://stormwater.pca.state.mn.us/index.php?title=Minnesota_plant_lists#Salt_tolerance), etc. The selection of plantings suitable to their immediate surroundings will minimize long-term care and replacement frequency.
- Specifying the optimized soil media composition and depth to effectively trap or sequester nutrients (phosphorus (https://stormwater.pca.state.mn.us/index.php?title=Phosphorus) in particular), and that can also support the desired vegetation.
- Providing educational signage to increase public awareness.
- Installing measures like low fencing to prevent damage from pedestrian foot traffic .

Designers should consult and include any local requirements regarding **green infrastructure**. O&M considerations often depend on whether the practice is located on public land, private land, or in the public right of way. For example, plantings in the public right of way that conflict with any traffic safety considerations could require increased O&M, such as pruning or complete removal.

Designers should also recognize the need to perform frequent landscaping maintenance to remove trash, check for clogging, and maintain vigorous and healthy vegetation. Designers can incorporate design solutions to facilitate maintenance activities. Examples include

- incorporating multiple and easy site access points;

- installing **observation wells**; and
- providing recommendations of vegetation appropriate to the location.

The designer should also provide a site-specific O&M plan that includes

- construction inspection schedule and checklists,
- post-construction routine maintenance schedule and checklists, and
- operating instructions for the practice (if applicable)

Example O&M plans are provided below. (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices#Example_O.26M_Plans.2C_Checklists.2C_Reports.2C_and_Maintenance_Agreements)

For more design information and criteria for individual infiltration practices, see the Design criteria for bioretention (https://stormwater.pca.state.mn.us/index.php?title=Design_criteria_for_bioretention) or Design criteria for infiltration practices (https://stormwater.pca.state.mn.us/index.php?title=Design_criteria_for_infiltration) pages.

Construction Phase O&M Considerations

Proper construction methods and sequencing play a significant role in reducing O&M problems. Some key items during the construction phase include the following.

1. **Before construction begins**
    1. Ensure that the contributing drainage area is fully stabilized with vegetation prior to the beginning of construction. Also make sure that impervious areas in the contributing drainage area are clean. If this is not possible, use barriers or diversions to direct stormwater flows from the contributing drainage area away from the practice. See Sediment control practices for more information.
    2. Install any needed **erosion protection** (https://stormwater.pca.state.mn.us/index.php?title=Erosion_prevention_practices) and **sediment controls** (https://stormwater.pca.state.mn.us/index.php?title=Sediment_control_practices) in your construction site and prepare a storm water pollution prevention plan (https://stormwater.pca.state.mn.us/index.php?title=Construction_stormwater_permit_overview_and_permit_application#Create_a_Stormwater_Pollution_Prevention_Plan_.28SWPPP.29) (SWPPP). See Erosion prevention practices and Sediment control practices for more information.
    3. Designate a stormwater supervisor to make sure someone is responsible for erosion and sediment control.
    4. Hold a pre-construction meeting with the designer and the installer to review the construction plans and the sequencing of construction.
2. **During construction**

Demonstration of the rake technique with a bucket with teeth (top) and scoop technique using a bucket with a smooth blade (right). During the final pass of excavation, the rake technique should be used to break up the soil and promote exfiltration. Source: Dr. Robert Brown, ORISE Research Fellow, US EPA, Edison, NJ.

1. Construct any **pretreatment** (https://stormwater.pca.state.mn.us/index.php?title=Pretreatment) devices before constructing the main bioretention or infiltration system.
2. Ensure heavy equipment does not enter the footprint of the practice to avoid compaction of the infiltration media.
3. Store any soil or gravel media downstream of the practice footprint to avoid clogging the infiltration media. If this is not possible, store soil or gravel media in some type of covered or contained structure.
4. Inspect the practice during construction to ensure that the infiltration practice is built in accordance with the approved design standards and specifications. This includes verification of the media composition and depths. Use detailed inspection checklists that include sign-offs by qualified individuals at critical stages of construction and to ensure the contractor's interpretation of the plan is acceptable to the professional designer. Example construction phase inspection checklists are provided here (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices#Example_O.26M_Plans.2C_Checklists.2C_Reports.2C_and_Maintenance_Agreements).
5. Ensure that the plant and vegetation mix conforms to the vegetation design plan, particularly if the vegetation was selected to provide ecological function (such as pollinator habitat).

3. **After construction**
    1. Verify that the infiltration practice was built in accordance with the approved design and standards and specifications, including the pretreatment devices as well as the main infiltration practice.
    2. Verify that the contributing drainage area is fully stabilized with vegetation prior to removing any barriers, diversions, or erosion and sediment control measures.
    3. Verify that the practice actually captures and infiltrates runoff. Conduct a full inundation test to inspect the underdrain and outflow function. Conduct an infiltration test to verify post-construction infiltration rates. For more information, see Assessing the performance of infiltration or Assessing the performance of bioretention.
    4. Verify that the practice reduces nutrient loads. Collect inflow and outflow storm water samples and have them analyzed for nutrient concentrations.
    5. Use a detailed inspection checklist that includes sign-offs by qualified individuals at the completion of construction, to ensure that the contractor's interpretation of the plan is acceptable to the professional designer. Example construction phase inspection checklists are provided here (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices#Example_O.26M_Plans.2C_Checklists.2C_Reports.2C_and_Maintenance_Agreements).
    6. Review and discuss the plant warranty/establishment period with the plant provider to understand the conditions under which failing plants will be replaced.
    7. Determine if stormwater should be kept **offline** from the practice until the seedlings are established.
    8. The design/construction team should provide the O&M team with the following information to be included in the O&M plan:
        1. The plant warranty .
        2. The " **as-built**" plans of the practice
        3. A list of conditions that might cause failure of the practice if not properly maintained.

For information on construction specifications, see the links below.

- Construction specifications for infiltration
- Construction specifications for bioretention

Post-Construction Phase O&M

Effective short and long-term operation of bioretention and infiltration practices requires dedicated and routine maintenance. Proper maintenance will not only increase the expected lifespan of the facility but will improve ecological function, aesthetics, and property value. Important post-construction considerations are provided below.

- A site-specific Operations and Maintenance Plan should be prepared by the designer prior to putting the stormwater practice into operation. This plan should provide any operating procedures related to the practices. The plan should also provide clear maintenance expectations, activities, and schedules. Include photos if possible. Be clear about who is responsible for the maintenance and the type of expertise that will be needed for distinct O&M activities. The O&M plan should include an anticipated budget for O&M activities. The O&M plan should also include an example O&M inspection checklist and an example maintenance report. Example O&M plans and inspection checklists are provided here (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices#Example_O.26M_Plans.2C_Checklists.2C_Reports.2C_and_Maintenance_Agreements).

Photo showing maintenance of a bioretention practice. Image: Ramsey Washington Metro Watershed District (https://www.rwmwd.org/get-involved/stewardship-grants/).

- A legally binding and enforceable maintenance agreement should be executed between the practice owner and the local review authority. Example maintenance agreements are provided here (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices#Example_O.26M_Plans.2C_Checklists.2C_Reports.2C_and_Maintenance_Agreements).
- Inspection and maintenance activities are distinct and can be done as separate activities or together. Inspection will typically assess the practice for any O&M issues, whereas maintenance will address the O&M issues identified by the inspection. A dedicated inspection effort on a large number of BMPs can help prioritize maintenance activities.
- Maintenance activities should not cause compaction or damage to vegetation. No vehicles or stockpiling should be allowed within the footprint of the practice. Foot traffic should be kept to a minimum.
- Maintenance activities should apply to all parts of the bioretention or infiltration practices, including the pretreatment devices, the main bioretention/infiltration area, the vegetation, the media, and any conveyance or discharge pipes.
- BMP areas generally should not be used as dedicated snow storage areas. Click here (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Snow_storage) for additional snow and salt considerations.

Overview and schedule of general maintenance activities for bioretention and infiltration practices.
Link to this table

	First Year of Operation			
Activity	**Frequency**	**Time period**	**Level of effort**	**O&M benefit[a]**
Check that there is no ponding in the pretreatment device and/or in the main treatment area.	At least twice after storm events > 0.5 inches	Within the first 6 months	< 1 hour	1
Check for evidence of clogging in the pretreatment device and/or in the main treatment area.	At least twice after storm events > 0.5 inches	Within the first 6 months	< 1 hour	1

First Year of Operation

Activity	Frequency	Time period	Level of effort	O&M benefit[a]
Check for evidence of clogging or failing of the inlet, outlet, and bypass pipes.	At least twice after storm events > 0.5 inches	Within the first 6 months	< 1 hour	1
Remove any stormwater diversion or barriers once seedlings are established.	Once	When plants are sufficiently established	1-2 hours	1,2,3,4,5
Supplemental watering during drier periods, particularly if keeping stormwater offline until plant seedlings are established.	1/week initially	During first 2 months	1-2 hours	2,3,4,5,6
	As needed	First growing season	1-2 hours	2,3,4,5,6
Remove and replace dead plants	As needed	First growing season	2-4 hours	2,3,4,5,6
Spot reseeding of bare patches and eroding areas	As needed	First growing season	2-4 hours	1,2,3,4,5,6

After First Year of Operation

Activity	Frequency	Time period	Level of effort	O&M benefit[a]
Check that there is no ponding in the pretreatment device and/or in the main treatment area	Semi-annually	48 hours after a rain event and when ground is not frozen. Note that deep sumps can have ponding	1-2	1
Check for evidence of clogging in the pretreatment device, the inlets/outlets/bypass pipes, and in the main treatment area. Look for evidence of short circuiting or low spots that cause flow path issues.	Semi-annually	n spring and fall	1-2	1
Supplemental watering	As needed during extended dry periods	During dry periods	1-2 hours	2,3,4,5,6
Remove trash and debris from the pretreatment device and/or in the main treatment area.	Monthly during rainy season	All year long. Cleaning may need to be done more frequently during the summer storm season and less during the drier winter season	1-2 hours	1,5
Inspect for and remove excess sediment in the pretreatment device and/or in the main treatment area.	Monthly	All year long	4 hours if removal is needed	1
Check and repair eroded areas	Annually	In fall or spring when vegetation has died down	4 hours if repair is needed	1,2,3,4,5
Mow grass filter strips and bioretention turf cover	Seasonally, but outside of the main pollinator or wildlife nesting season	During growing season	1-2 hours	2,3,4,5

First Year of Operation

Activity	Frequency	Time period	Level of effort	O&M benefit[a]
Weed and remove invasive plants	Twice during growing season	During growing season	1-2 hours	2,3,4,5
Inspect plant composition and health and replace as needed	Annually	In fall or spring	4 hours if plant replacement is needed	2,3,4,5,6
Prune trees and shrubs	Annually	In fall or spring	2-4 hours	2,3,4,5
Inspect for and repair broken inlets or pipes	As needed	Any time	2 hours, more if repairs are needed	1
Renew mulch[b]	As needed	In fall or spring	1-2 hours	4,5
Spring cleanup (cut back and remove last year's material)	Annually	In spring	2-4 hours	2,3,4,5
Fall cleanup (removed excessive leaf litter, particularly in areas with lots of trees)	Annually	In fall	2-4 hours	2,3,4,5

After 5+ Years of Operation (non-routine maintenance)

Activity	Frequency	Time period	Level of effort	O&M benefit[a]
After long term operation of the practice, some occasional and infrequent maintenance activities might be required, such as bigger repairs, soil regeneration, or redesign of key elements of the practice.	As neede	As needed	Could be significant depending on the activity	1,2,3,4,5,6

[a]Key to Maintenance Benefits:

1. Proper stormwater flow and infiltration
2. Creation and maintenance of wildlife habitat
3. Creation and maintenance of pollinator habitat
4. Nutrient cycling and storage
5. Aesthetics and public enjoyment
6. Carbon sequestration

[b]Note that many practitioners are minimizing the use of mulch or using alternatives to mulch to control weeds. Using mulch can cause clogging of inlet, outlet, and bypass pipes, and can introduce invasive species such as jump worms. Alternatives to mulch include ground vegetation such as clover or sedges, or arranging plantings in more dense configurations so as to minimize use of mulch.

Common problems and how to troubleshoot them for bioretention and infiltration practices
Link to this table

Symptom	Possible causes	Solution

Symptom	Possible causes	Solution
Standing water within the infiltration area for more than 48 hours	The surface of the ponding area may become clogged with fine sediment over time. This might be because the pretreatment is no longer working, or there are excessive sediment loads due to erosion or high sediment loads from the contributing area.	▪ Clean the pretreatment area with more frequency. ▪ Scrape, clean or vacuum the infiltration area. A vacuum truck may be needed for sediment removal in the pretreatment are or BMP proper. All sediments may be subjected to the MPCA's guidance for reuse and disposal ▪ Address any erosion through more plantings. ▪ Core aeration or cultivating of non-vegetated areas may be required to ensure adequate infiltration.
Rainwater does not appear to flow to the infiltration area	Leaves, sediment, trash, or plant debris may be blocking the flow path.	Remove these materials on a regular basis
Vegetation is not able to establish	Plant selection is inappropriate for the site	Consult with a landscaper or horticulturist. Check that plants are suited to the local conditions. Make sure BMP is protected from snow storage or salt application.
Erosion or scouring around the inlet	Flow is obstructed by debris or improper grading	Correct for drainage and flow path issues to make sure flows are evenly distributed. Make sure the flow paths are unobstructed.

Maintenance Costs

Maintenance costs will vary with a number of factors, including but not limited to

- size of the practice and its contributing drainage area,
- type of plantings used,
- site visit frequency,
- level of maintenance needed,
- local weather conditions,
- staffing needs (number of staff, external vs. internal staff, etc.),
- travel time between sites,
- efficiencies of scale (single GI vs. a cluster of GI), and
- equipment needed.

Preventative maintenance is key to minimizing major costs associated with repairs. A general rule of thumb to estimate maintenance costs is 3%-6% of the installation costs, but can run higher. Maintenance may be higher the first few years, while plants are being established. Maintenance costs should account for the number of hours of labor, the cost for different types of labor expertise required, and any equipment needed to successfully complete the maintenance activities.

A study published in 2017 by the American Society of Civil Engineers (ASCE) shows the median annual maintenance cost of bioretention devices was estimated at $0.687/sq ft with lower and higher costs of $0.13/sq ft and $2.30/sq ft, respectively. The survey also provides average annual reported maintenance costs, which range from $250 to $3880 with a median of $850 (Clary, 2017 (https://owl.cwp.org/mdocs-posts/cost-of-maintaining-green-infrastructure/)).

Useful Resources

Supplemental information can be found on the page called Operation and maintenance of bioretention and other stormwater infiltration practices - supplemental information. Supplemental information includes the following.

- Erosion protection and sediment monitoring, removal, and disposal (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Erosion_protection_and_sediment_monitoring.2C_removal.2C_and_disposal_.E2.80.93_protecting_your_investment)
- Seeding, planting, and landscaping maintenance (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Seeding.2C_planting.2C_and_landscaping_maintenance_.E2.80.93_keeping_it_looking_good)
- Snow storage (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Snow_storage)
- Sustainable service life for infiltration and bioretention BMPs (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Sustainable_service_life_for_infiltration_and_bioretention_BMPs)
- Maintenance agreements (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#Maintenance_agreements)
- References (https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_of_bioretention_and_other_stormwater_infiltration_practices_-_supplemental_information#References)

Case Studies

- None identified that specifically include maintenance considerations.

Maintenance Training Documents and Videos

- Chesapeake Stormwater Network TECHNICAL BULLETIN No. 10 (https://chesapeakestormwater.net/2013/04/technical-bulletin-no-10-bioretention-illustrated-a-visual-guide-for-constructing-inspecting-maintaining-and-verifying-the-bioretention-practice/). Bioretention Illustrated: A Visual Guide for Constructing, Inspecting, Maintaining and Verifying the Bioretention Practice
- Archived webcast from Chesapeake Stormwater Network (https://chesapeakestormwater.net/events/webcast-ms4-implementers-and-the-bay-tmdl-urban-bmp-verification/) - TRUST BUT VERIFY: Urban BMP Verification in the Chesapeake Bay
- Archived webcast from Chesapeake Stormwater Network (https://chesapeakestormwater.net/events/webcast-bioretention-maintenance/) - Bioretention Maintenance: In the Trenches
- MSD Rain Garden and Planter Box Maintenance video (https://www.youtube.com/watch?v=nK4x1rtyMds)
- DOEE RiverSmart Rain Garden Maintenance video (https://www.riversmarthomes.org/video-series)

O&M Resource Catalog

MPCA has compiled publicly available O&M resources related to green infrastructure. This non-exhaustive catalog is intended as a resource to practitioners (https://docs.google.com/spreadsheets/d/1TNGVghLhudcWPgXKLbLAu2cUWv6O3ZeS7-FIuLSGIPM/edit#gid=0).

Example O&M Plans, Checklists, Reports, and Maintenance Agreements

- Operation & Maintenance Plan
  - County of Napa, CA, Example Stormwater Treatment Facilities Operations and Maintenance Plan for a Commercial Project (https://www.countyofnapa.org/DocumentCenter/View/3028/Example-OM-Plan-for-Residential-PDF)
  - County of Napa, CA, Example Stormwater Treatment Facilities Operations and Maintenance Plan for a Residential Project (https://www.countyofnapa.org/DocumentCenter/View/3028/Example-OM-Plan-for-Residential-PDF)
- Construction phase inspection checklist
  - Bioretention construction inspection checklist (https://stormwater.pca.state.mn.us/index.php?title=File:Bioretention_-_construction_inspection_checklist.xlsx) (link to table (https://stormwater.pca.state.mn.us/index.php?title=Bioretention_-_construction_inspection_checklist))
  - Infiltration basin - system construction inspection (https://stormwater.pca.state.mn.us/index.php?title=File:Infiltration_basin_-_system_construction_inspection_checklist.xlsx) (link to table (https://stormwater.pca.state.mn.us/index.php?title=Infiltration_basin_-_system_construction_inspection_checklist))
  - Infiltration trench construction inspection checklist (https://stormwater.pca.state.mn.us/index.php?title=File:Infiltration_trench_construction_inspection_checklist.xlsx) (link to table (https://stormwater.pca.state.mn.us/index.php?title=Infiltration_Trench_-_Construction_inspection_checklist))
- O&M inspection checklist
  - Bioretention - operation and maintenance checklist (https://stormwater.pca.state.mn.us/index.php?title=File:Bioretention_-_operation_and_maintenance_checklist.xlsx) (link to table (https://stormwater.pca.state.mn.us/index.php?title=Bioretention_-_operation_and_maintenance_checklist))
  - Infiltration trench basin operation maintenance checklist (https://stormwater.pca.state.mn.us/index.php?title=File:Infiltration_trench_basin_operation_maintenance_checklist.xlsx) (link to table (https://stormwater.pca.state.mn.us/index.php?title=Infiltration_trench/basin_%E2%80%93_operation_and_maintenance_checklist))
- O&M example report
  - MSD Example (https://portal.laserfiche.com/Portal/DocView.aspx?id=3361965&repo=r-a96260ce)
- Maintenance Agreements
  - Example Maintenance Agreement 1 (https://stormwater.pca.state.mn.us/index.php?title=Example_Maintenance_Agreement_1)
  - Example Maintenance Agreement 2 (https://stormwater.pca.state.mn.us/index.php?title=Example_Maintenance_Agreement_2)
  - Example Maintenance Agreement 3 (https://stormwater.pca.state.mn.us/index.php?title=Example_Maintenance_Agreement_3)

References

- Drescher, S.R., Karen Cappiella, Greg Hoffman, and Bryan Siepp. 2012. Trees in Bioretention (https://owl.cwp.org/mdocs-posts/trees-in-bioretention/). Center for Watershed Protection, Inc., Ellicott City, MD.
- Clary, J., Piza, H. 2017. Cost of Maintaining Green Infrastructure (https://owl.cwp.org/mdocs-posts/cost-of-maintaining-green-infrastructure/). American Society of Civil Engineers (ASCE), Reston, VA.

Related pages

- Operation and maintenance of bioretention and other stormwater infiltration practices
- Operation and maintenance of green roofs
- Operation and maintenance of vegetated strips
- Operation and maintenance of permeable pavement
- Operation and maintenance of tree trenches and tree boxes
- Operation and maintenance of vegetated swales
- Operation and maintenance of stormwater treatment wetlands
- Operation and maintenance of rainwater harvesting

Supplemental guidance

- Supplemental guidance - operation and maintenance of bioretention and other stormwater infiltration practices
- Supplemental guidance - operation and maintenance of green roofs
- Supplemental guidance - operation and maintenance of vegetated strips
- Supplemental guidance - operation and maintenance of permeable pavement
- Supplemental guidance - operation and maintenance of tree trenches and tree boxes
- Supplemental guidance - operation and maintenance of vegetated swales
- Supplemental guidance - operation and maintenance of stormwater treatment wetlands
- Supplemental guidance - operation and maintenance of rainwater harvesting

/* Manually replaced by abbott Aug 6 '21 */